THE WEATHER AND CIRCULATION OF MARCH 1962

A Month With an Unusually Strong High-Latitude Block

JULIAN W. POSEY

Extended Forecast Branch, U.S. Weather Bureau, Washington, D.C.

1. HIGHLIGHTS

March 1962 was a cold month in most of the United States, thus continuing the trend which began in mid-February [1]. The cold was associated with a major zonal index cycle, the recovery phase of which occurred in March. Strong blocking with record-breaking 700-mb. height anomalies was observed in the Atlantic and eastern North America. The outstanding weather feature of the month was the "Great Atlantic Coast Storm" [2] with its devastating tidal surges along the east coast of the United States.

Figure 1 shows that the mean 700-mb. circulation for March was one of blocking over the Atlantic Ocean and eastern North America, but shorter-period averages point to a sequence of patterns slowly evolving from a very strong meridional flow over the Atlantic and parts of North America at the beginning of the month to a definitely zonal flow by the end of the month.

2. MEAN CIRCULATION

Monthly records of 700-mb. height anomalies for the western portion of the Northern Hemisphere since 1933 show only one other March in which a positive anomaly approached the 750-ft. positive departure over the Davis Strait (fig. 1). March 1958 had a mean monthly departure of +730 ft. over Quebec with a negative center of 360 ft. located southeast of Newfoundland. In 1962, however, the negative anomaly of 440 feet (fig. 1) over the Atlantic and the 750-ft. positive anomaly to the north are much more impressive than the anomaly pair of 1958 in the same general region. The mean sea level high pressure shown in figure 2 over Greenland was also higher than any mean March pressure in the period beginning with 1933.

The westerlies were displaced well south of normal over the Atlantic Ocean and the eastern United States (fig. 3) as a result of the high-latitude blocking. The core of the strongest westerlies was 5° to 10° south of its average March location across the Atlantic. Along with the displaced westerlies, migratory storms moved across the Atlantic on a more southern track (Chart IX of [3]). The 700-mb. Low near Newfoundland was almost 30° south of its normal position in the northern Davis Strait. In fact, the low pressure normally over the Davis Strait was replaced by a strong ridge which was associated with the anticyclonic center along the southern coast of Greenland.

Study of figures 1 and 3 shows that zonal flow was predominant over the Pacific Ocean with the main mid-latitude westerly belt at 700 mb. about 5° north of the normal position. The ridge in the eastern Pacific extended into the Gulf of Alaska where the flow is normally cyclonic. The low-latitude trough west of Hawaii was also a noticeable departure from the normal. The trough line in the western Pacific during March was about 5° to 10° west of its normal position in middle latitudes and 700-mb. heights were almost 300 ft. below normal in eastern Asia north of Korea. Across the remainder of Asia, the circulation exhibited no large extremes. Greatest variations were the southwestward shift of the Novaya Zemlya depression and the 5° to 10° westward displacement of the ridge normally near Lake Baikal.

3. INDEX CYCLE

The zonal index was 13.5 m./sec. for the 5-day period centered January 25, 1962; thereafter, the mid-latitude westerlies (35° to 55° N.) across North America and nearby oceans decreased sharply and steadily during February [1] to a value of only 3.8 m./sec. for the 5-day period centered on February 26. Then, with the recovery encompassing all of March, the westerlies gradually increased to 11.4 m./sec. for the 5-day period centered April 2. Figure 4A shows the remarkable symmetry of the cycle. Reference to the daily values reveals that there were 35 days on the downward phase and 35 days on the recovery. This represents a period of 70 days for this cycle which is considerably longer than the average of "about six weeks for winter" given by Willett [4]. The duration in this case exceeded all of the examples for the years shown by Namias [5] in 1950, although in the winter of 1947 one of similar magnitude occurred. Upon checking later available records, no year was found to have an index cycle comparable in all three elements—period, amplitude, and symmetry.

From a comparison of figures 4A and B (see also fig. 3) it is evident that much of the low index of middle latitudes was the result of westerlies displaced southward in the Atlantic. The subtropical westerlies varied inversely as the mid-latitude westerlies—a common circumstance [5]. However, the westerlies in the low latitudes did not vary as regularly as did those in middle latitudes, and the strongest subtropical westerlies did not exactly correspond in time to the weakest mid-latitude flow.

4. AVERAGE MONTHLY WEATHER

TEMPERATURE

Temperatures averaged below normal over most of the United States during March (fig. 5A) with the largest negative departures, more than 8° F., in north-central Montana. The only sections with temperatures appre-

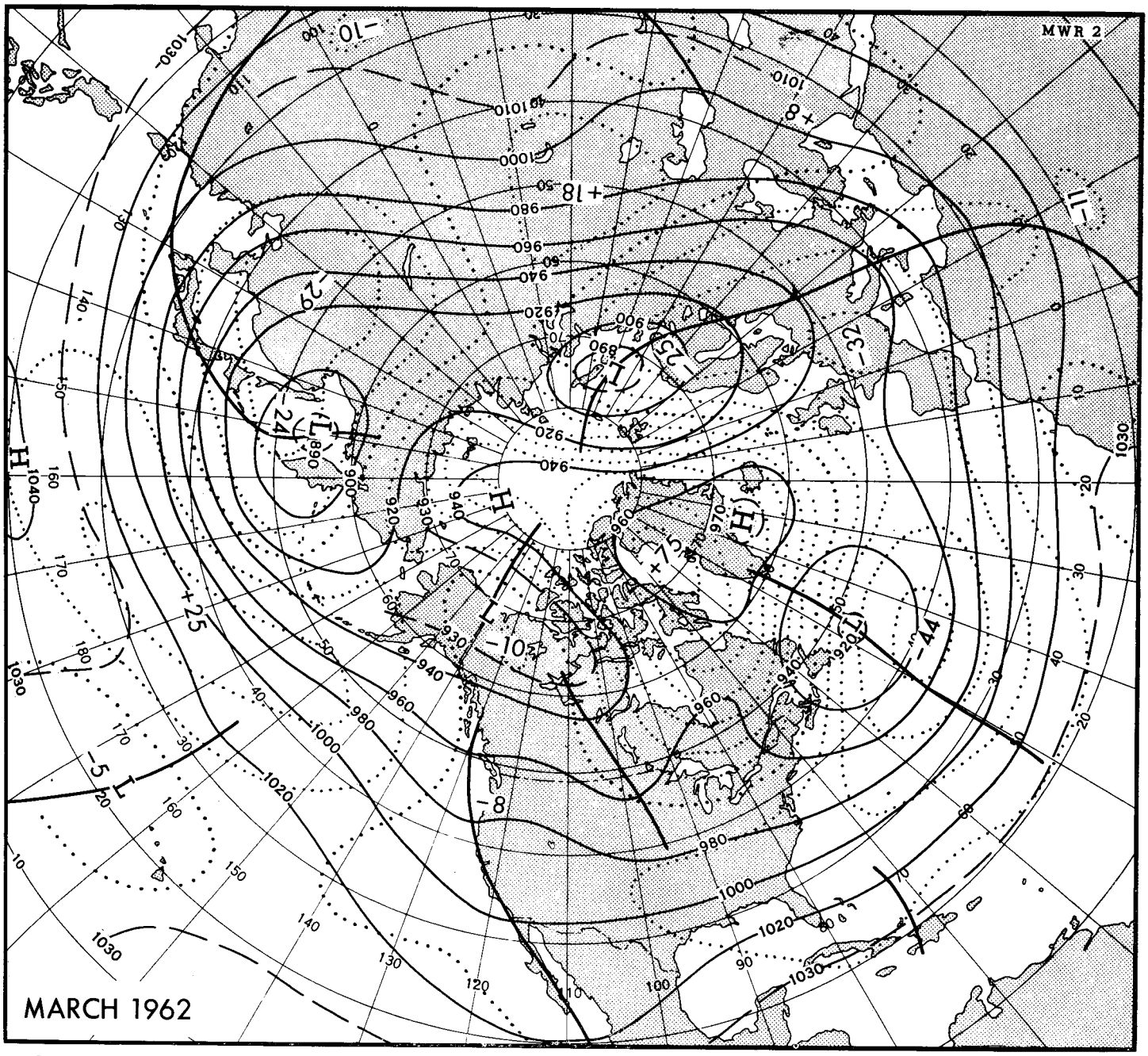

FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for March 1962.

ciably above normal were the Northeast and the Great Lakes region. Greatest positive departures, as much as 8° F., were observed in northern Maine.

There was fairly close correspondence between the anomalies of 700-mb. height and surface temperature during March over much of the United States. Figures 1 and 5A show that across the Northeast and through southern Michigan the zero lines of height and temperature anomaly were very close, but farther west the 700-mb. heights were above normal over a larger area than that covered by above normal temperatures. Two of the colder pockets, one in Montana and the other centered along the borders of eastern Nebraska and South Dakota, are more intense than would probably be expected from the small negative 700-mb. departures over these areas [6]. Temperatures 4° to 6° F. below normal were reported over much of Iowa, Nebraska, South Dakota, and Montana with up to 8° F. below in Montana; yet, 700-mb. heights were less than 50 ft. below normal along with a southeasterly anomalous flow both at the surface and aloft (figs. 1 and 2). These two areas of negative temperature anomaly are less surprising when snow cover is considered. Large portions of Iowa, Nebraska, South Dakota, and Montana had unusually widespread and continuous snow cover the first half of the month with some of these areas having snow cover more extensive than normal during all of March. The refrigerating effect of the extra snow

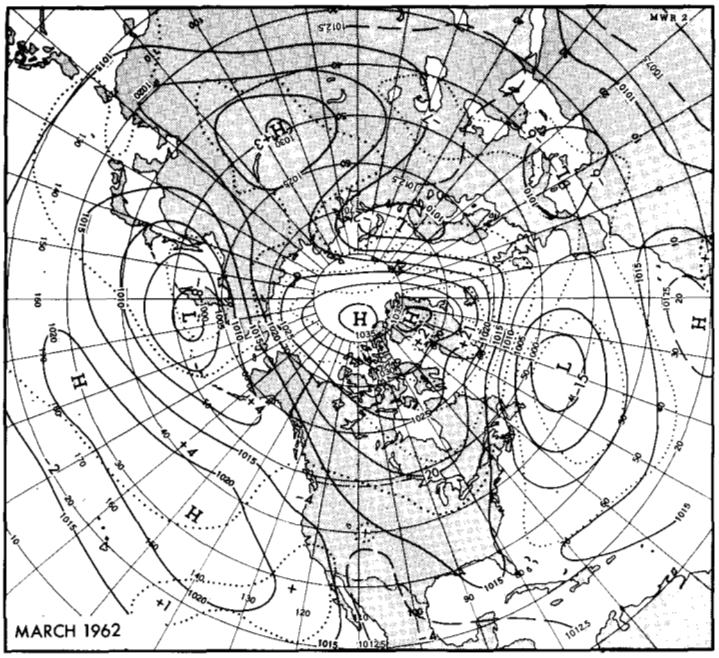

FIGURE 2.—Mean sea level isobars (solid) and departures from normal (dotted), both in millibars, for March 1962.

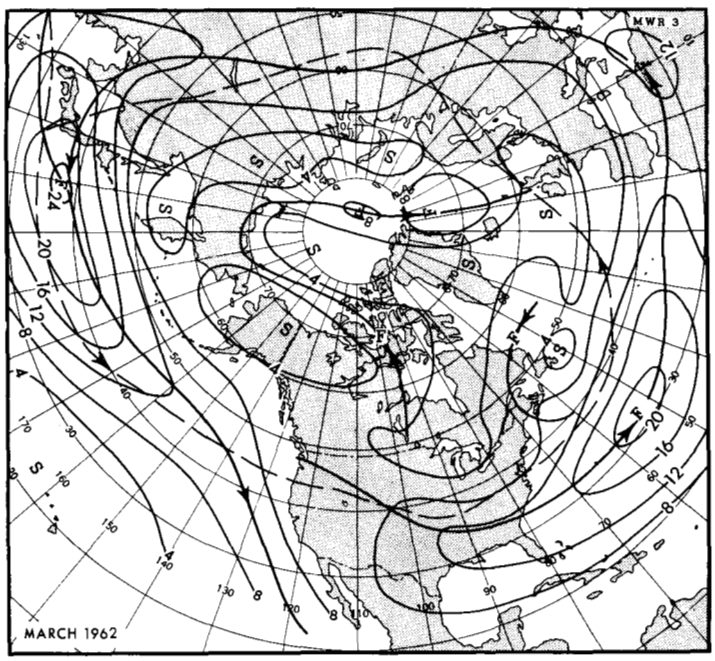

FIGURE 3.—Mean 700-mb. isotachs (meters per second) for March 1962. Heavy solid lines are principal axes of maximum wind, and dashed line is the normal March position.

cover could easily account for the observed temperature pattern in and near Iowa [7].

PRECIPITATION

The March precipitation pattern over the United States (fig. 5B) was rather complex with no continuous large areas showing either extreme dryness or very heavy rainfall. Actually the areas of above normal precipitation extended over approximately 40 percent of the United States, but the areas exceeding 150 percent of normal

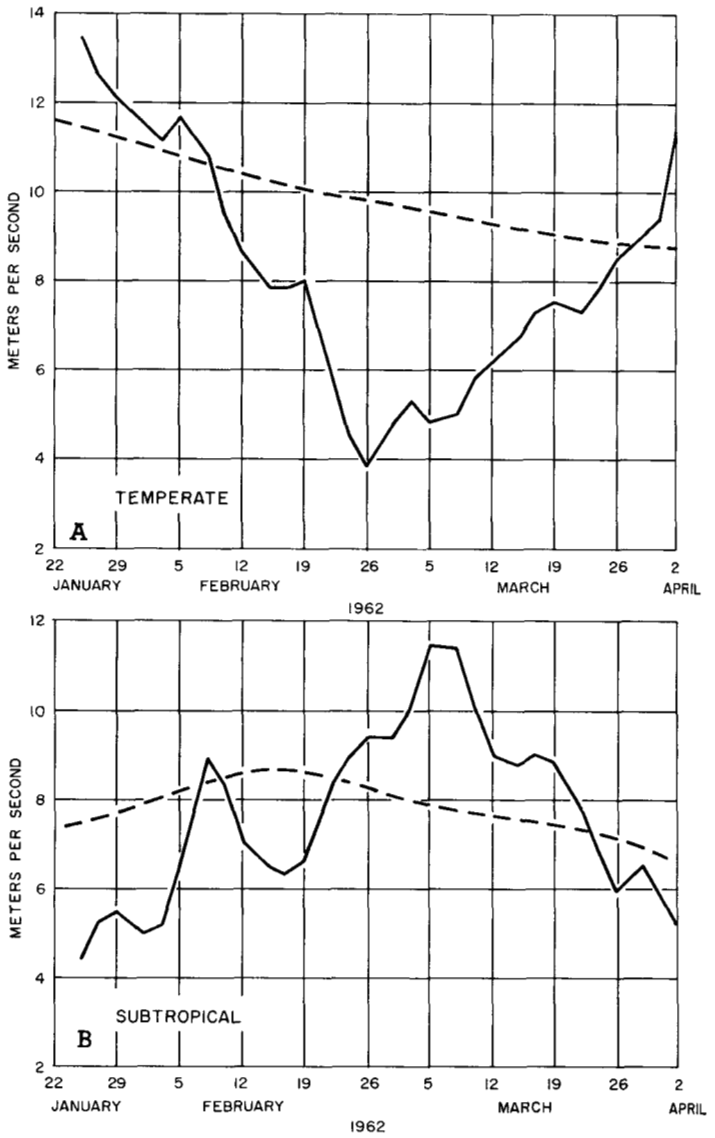

FIGURE 4.—(A) Time variation of speed of 700-mb. westerlies averaged between latitudes 35° and 55° N. from 5° W. to 175° E. Solid line connects 5-day mean zonal index values (plotted at the middle of period and computed thrice weekly), while dashed line gives the corresponding normal. (B) Index between latitudes 20° and 35° N.

were widely scattered and totaled only a very small percentage of the country. The areas where less than 50 percent of normal occurred were also fairly small yet scattered from Maine to southern California in ten different regions.

The spatial variability of precipitation this month can be reasonably inferred from the circulation shown in figure 1. Heavier precipitation in the eastern Dakotas, western Minnesota, and extending through Nebraska and Kansas was in an area of maximum cyclonic curvature, while heavy precipitation in the Southeast was associated with the southward-displaced westerlies as shown in figures 1 and 3. The trough along the west coast and the relatively flat westerly flow just to the east combined with terrain effects to cause the large area of above normal precipitation in the Rocky Mountain States. Even the

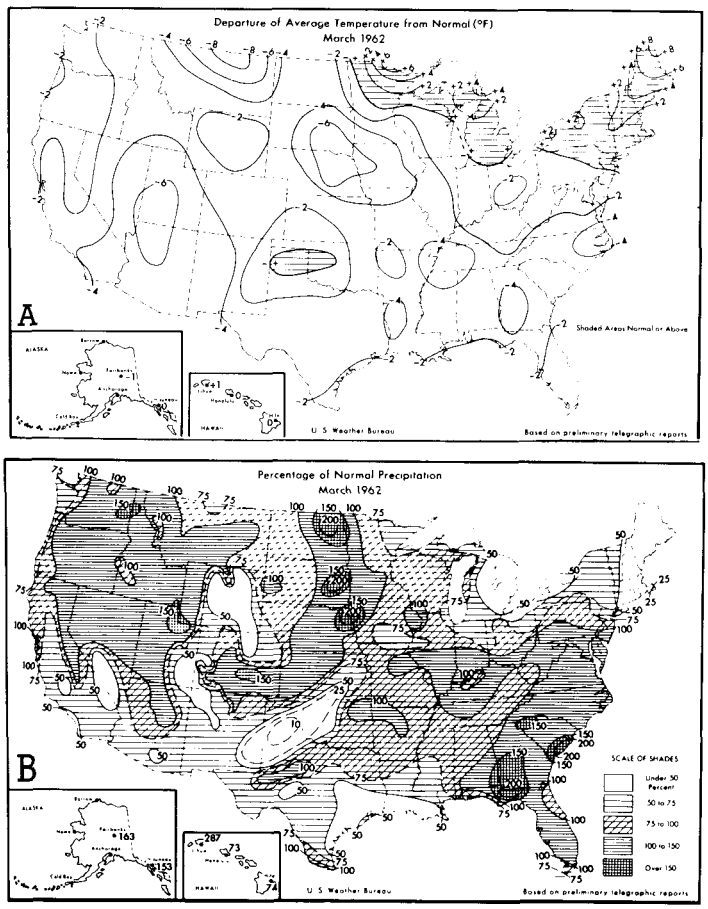

FIGURE 5.—(A) Mean temperature departures from normal (° F.) for March 1962. (B) Percentage of normal precipitation for March 1962. (From [9].)

dry area in Wyoming was consistent with the mean 700-mb. pattern as it was in the eastern portion of a weak ridge, and weak anticyclonic curvature also prevailed over the relatively dry area near the Texas and Louisiana coasts.

5. INTRA-MONTHLY VARIATIONS IN WEATHER AND CIRCULATION

Although in the mean most of the United States was colder than normal and the circulation was of a strong blocking character along the east coast of North America, the circulation and temperature regimes changed considerably through the month. The only part of the country to maintain below normal temperatures all the month was most of Iowa, eastern South Dakota and Nebraska, and southern Minnesota.

TABLE 1.—*Selected stations for which new minimum monthly temperature records were established in March 1962*

Station	Minimum temperature (°F.)	Date
Rockford, Ill.	−11	1
Waterloo, Iowa	−34	1
Alpena, Mich.	−27	2 and 4
Duluth, Minn.	−28	1
Minneapolis, Minn.	−32	1
Green Bay, Wis.	−29	1
Madison, Wis.	−29	1

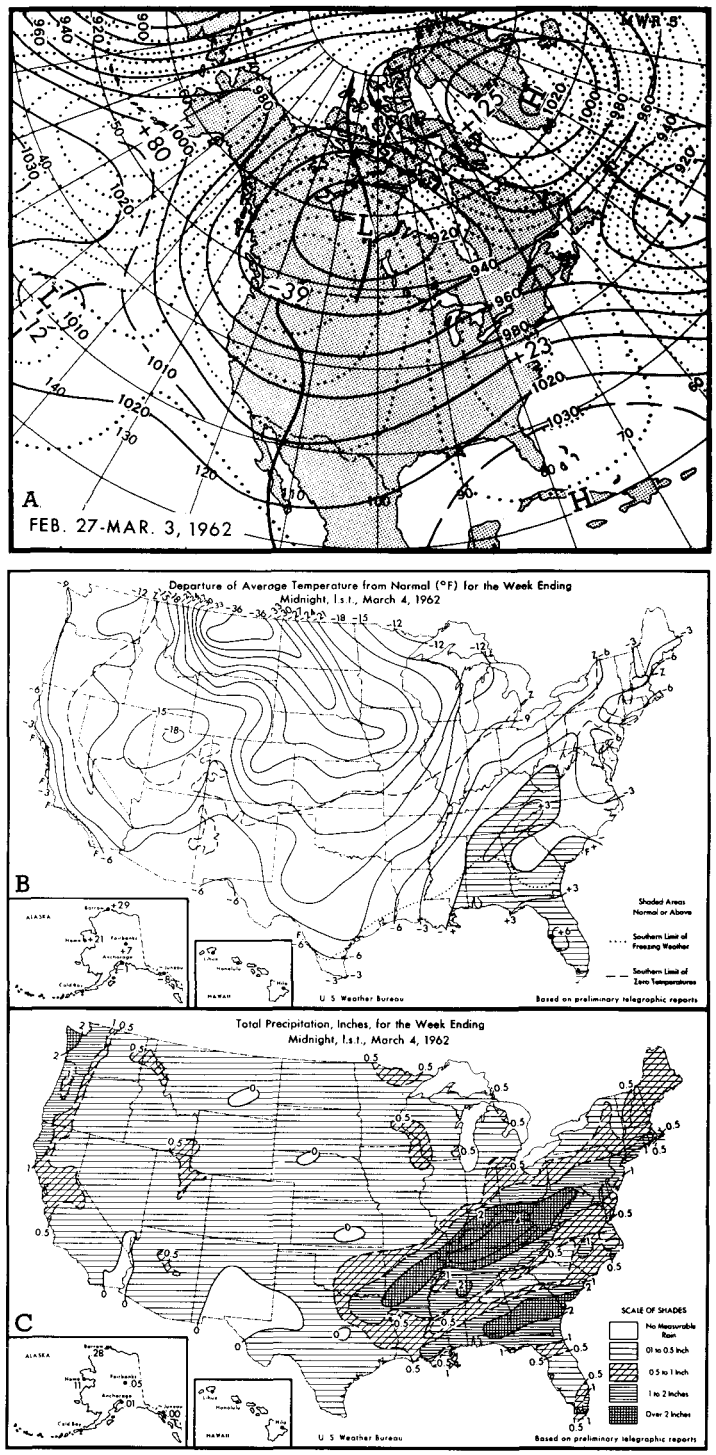

FIGURE 6.—(A) 5-day mean 700-mb. height and departure from normal, (B) surface temperature departure from normal, and (C) total precipitation, all for week ending March 4, 1962. (B and C from [9].)

WEEK ENDING MARCH 4

March began with very intense cold over most of the nation as indicated in figure 6B. Twenty-two cities in 11 States established record daily minimum temperatures on the 1st day of March. Some of the larger extremes are shown in table 1. This unseasonable cold was associated with a broad cyclonic mean circulation at 700 mb.

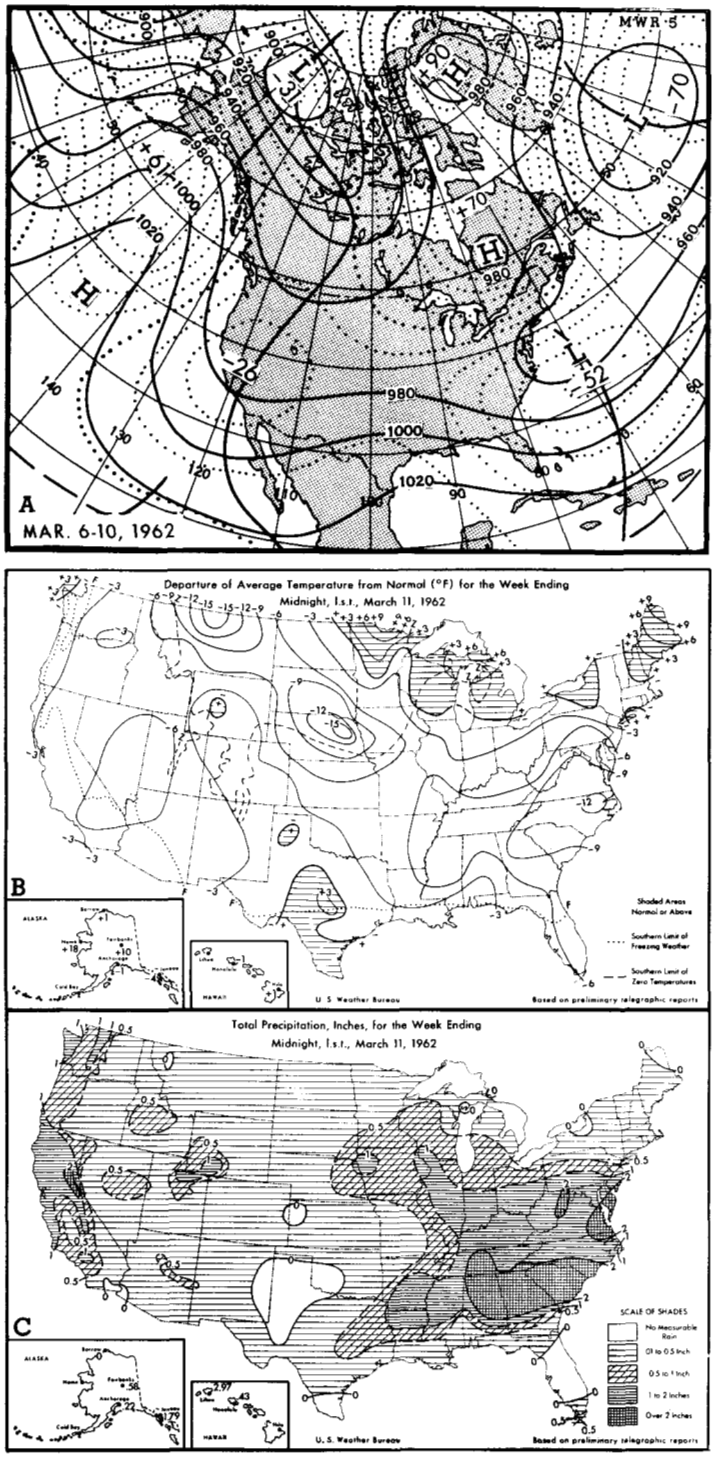

FIGURE 7.—(A) 700-mb. height and departure from normal, (B) surface temperature departure from normal, and (C) total precipitation, all for week ending March 11, 1962. (B and C from [9].)

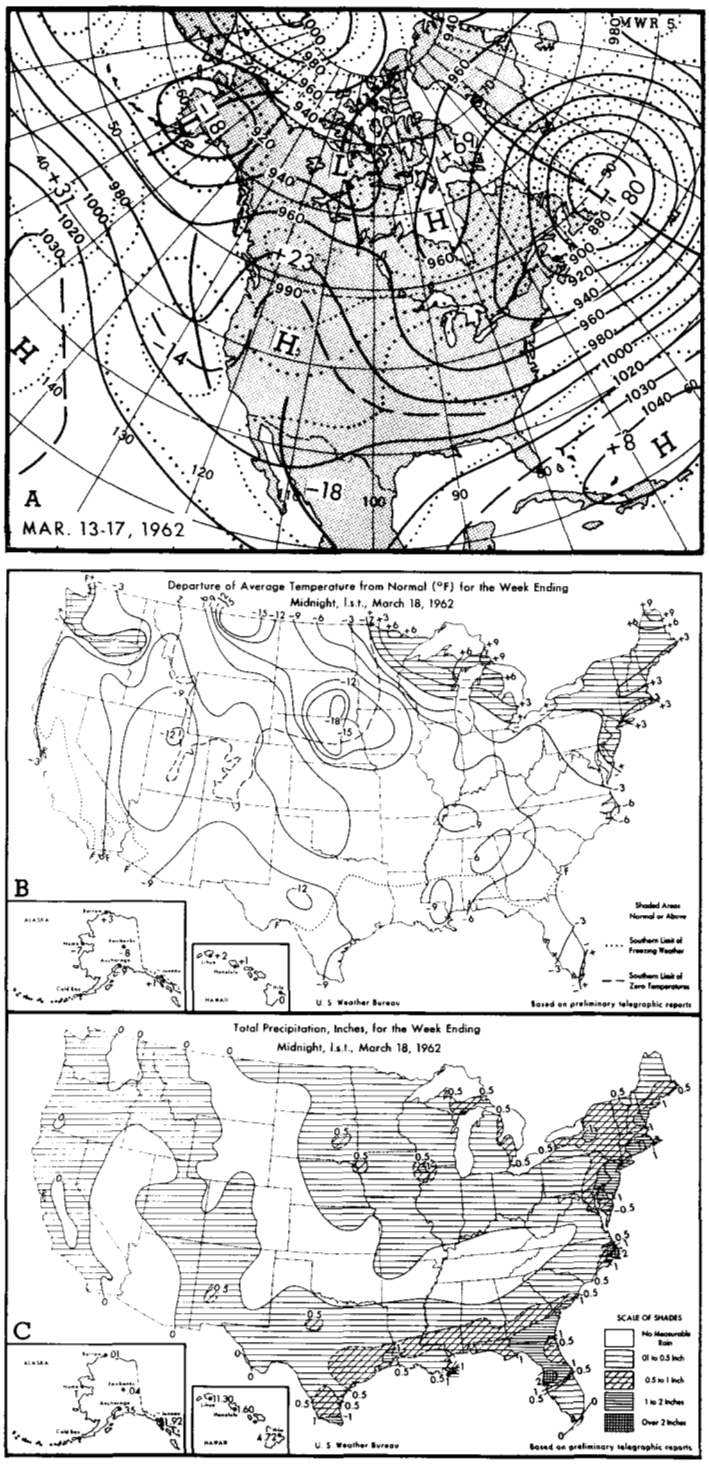

FIGURE 8.—(A) 700-mb. height and departure from normal, (B) surface temperature departure from normal, and (C) total precipitation, all for week ending March 18, 1962. (B and C from [9].)

that covered most of the nation (fig. 6A). A strong block lay downstream over the North Atlantic and Greenland.

All except a few isolated areas of the country received some precipitation in the period ending March 4, but in the Plains and Rocky Mountain States as well as near the Great Lakes, amounts were generally less than 0.05 inch (fig. 6C).

WEEK ENDING MARCH 11

During the second week of March, retrogression of the high-latitude blocking and the low-latitude trough-ridge pattern over and near North America resulted in a warming trend over much of the United States bringing above normal temperatures to New England, New York, and around the Great Lakes (fig. 7A and B). The warming

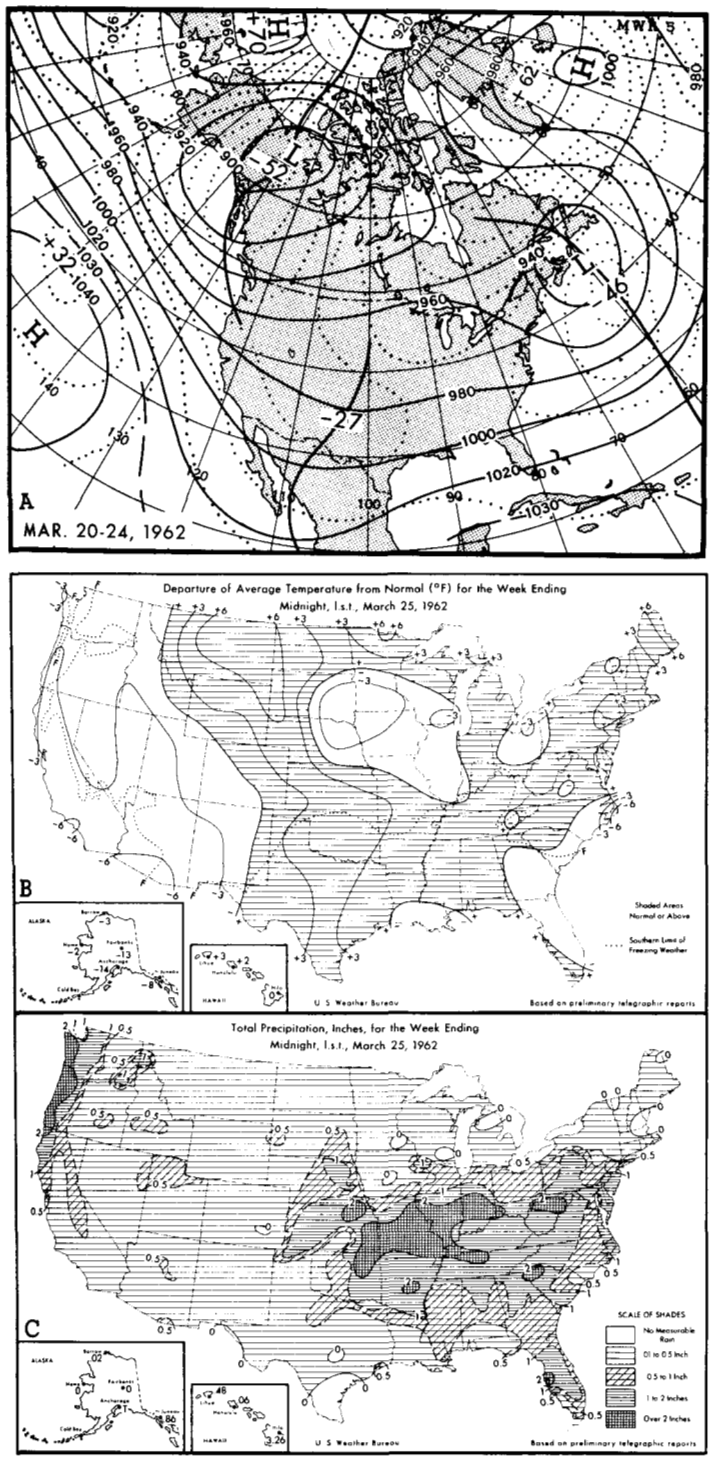

FIGURE 9.—(A) 700-mb. height and departure from normal, (B) surface temperature departure from normal, and (C) total precipitation, all for week ending March 25, 1962. (B and C from [9].)

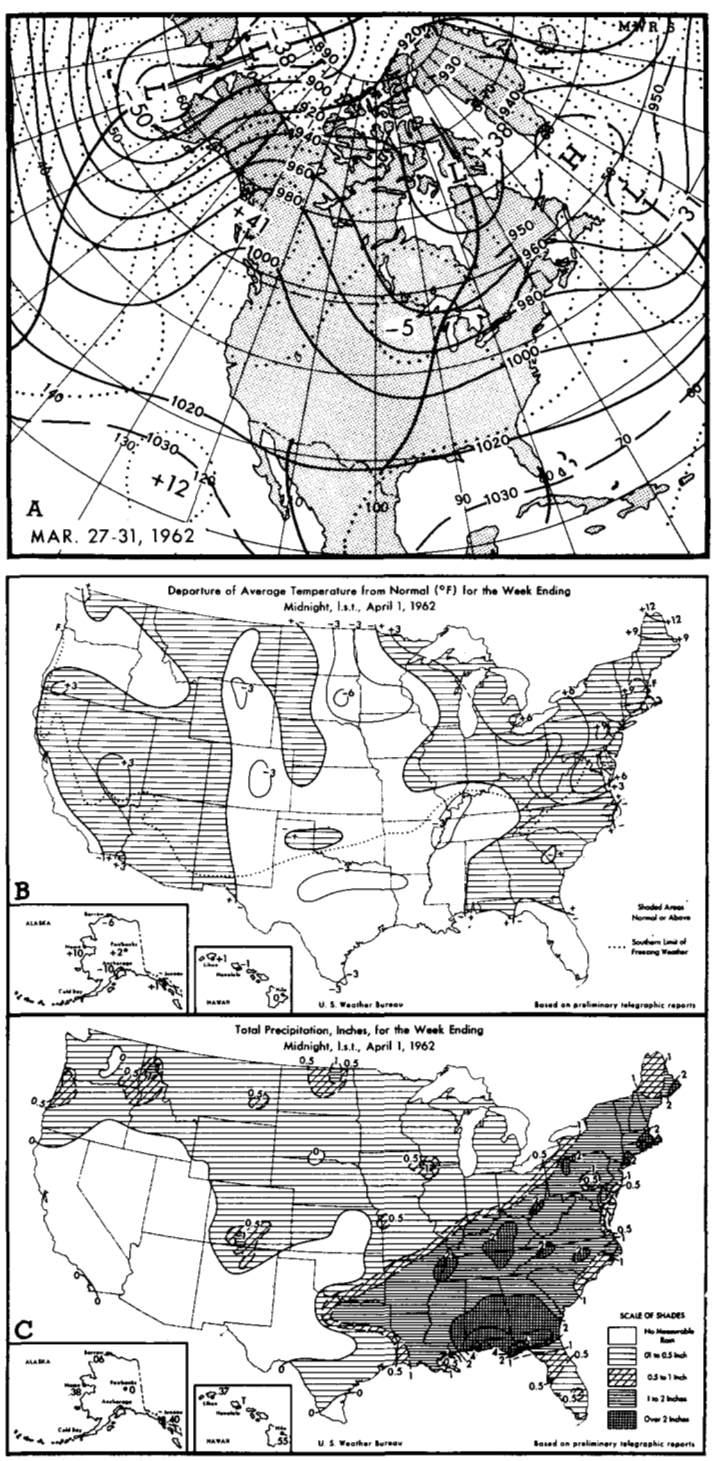

FIGURE 10.—(A) 700-mb. height and departure from normal, (B) surface temperature departure from normal, and (C) total precipitation, all for week ending April 1, 1962. (B and C from [9].)

is well reflected in the southwestward push of the strong anomalous easterly flow present around Labrador the previous week. This anomalous thrust caused maritime polar air to replace the usual and colder continental polar air in the areas of above normal temperature. The 700-mb. ridge in figure 7A over the southern Plains States and the lower Mississippi Valley resulted in some above normal temperatures in Texas. The only section of the country to experience much cooling was the Southeast where above normal temperatures fell to below normal, as southeasterly flow was replaced by northwesterly flow.

The heavy precipitation shown in eastern United States in figure 7C was to the north of the main storm track which remained south of normal as illustrated by the very low-latitude 700-mb. westerlies off the Florida coast. Retrogression of the low-latitude trough to near

the west coast resulted in 1 to 2 inches of rain in large sections of California in this period.

Occurring in this week was the unusually severe Atlantic storm of March 5 to 9. Antecedent conditions for the intense surface development were set up by retrogression of the strong blocking circulation in the North Atlantic. On March 5 a weak coastal Low moving north off the east coast of Florida came under the influence of a strong upper-level vortex which had moved southeastward from Iowa the preceding day. Rapid deepening of the surface system resulted as the two systems merged near the North Carolina coast. Movement after this time was very slowly east-northeastward as the storm became elongated in shape ([8] or [2]). A very long fetch of northeasterly winds developed which raised spring tides to record high levels. The surge caused by the storm occurred in many locations on four or five successive high tides along the east coast of the United States [2]. Winds, which reached hurricane force (gusts to 84 m.p.h. at Block Island, R.I. and 80 m.p.h. at Chesapeake Light Ship off Cape Henry, Va.), and the tidal surges caused extensive damage from New England to Florida. There was also record-breaking snowfall inland in Virginia and Maryland during this storm; approximately 3 ft. of snow fell at Waynesboro, Va.

According to the latest reports 34 deaths occurred in the storm and widespread damage resulted, inland, along the coast, and at sea, reaching almost $200 million. For details of the damage see [2], [10], [11].

WEEK ENDING MARCH 18

The warming trend over the majority of the country in the previous week was halted this week (fig. 8B) and in some localities reversed, as the very strong positive anomaly at 700 mb. over Davis Strait weakened, with the largest positive departures now appearing over the Arctic Ocean northwest of Alaska. Figure 8A shows a ridge over the Rockies directly north of a trough in Mexico. The Rocky Mountain ridge allowed a resurgence of cold air in the Plains States and into some of the South Central States. Daily surface charts show a Great Basin High during much of this period which resulted in up to 6° F. cooling in Utah.

The more westerly flow at 700 mb. in eastern United States was related to a shift northward of the main storm track bringing heavier precipitation to New England, while the thrust of dry cold air east of the Rocky Mountain ridge spread to the southern Appalachians giving the large dry area in figure 8C. The Great Basin High was associated with little or no rain. Heavy rain in Florida occurred with a Gulf of Mexico development late in the period indicating a tendency for return to the low-latitude storm track prevalent in recent weeks.

WEEK ENDING MARCH 25

By this period, the pronounced retrogression in the early part of March had stopped and progression was occurring with a 700-mb. ridge (fig. 9A) now over the Great Lakes and extending toward the Gulf of Mexico. The mid-tropospheric flow across the United States was much more zonal, and the resulting temperatures were above normal over large portions of the central and eastern States for the first time this month. Except for the extreme Northwest, the region west of the trough in the Plains States also experienced higher temperatures than in the preceding week. However, the northerly component of the main air stream over the western part of the country was enough to keep temperatures below normal west of the Rockies. The isolated area of below normal temperature in and adjacent to Iowa was the result of the unusual snow cover persisting in this section.

Two rather intense storms moved out of the mean trough in the Texas Panhandle and spread heavy precipitation eastward into the Ohio Valley (fig. 9C). The heavy rains along the Washington and Oregon coast resulted from the mean trough and strong onshore westerlies in that area.

FINAL WEEK OF MARCH

In general, progression of troughs and ridges over and near the United States continued in the final week of March (fig. 10A). The ridge along each coast and the trough in the Mid-West are reflected in the above normal temperatures to the east and to the west with below normal temperatures in the middle of the country (fig. 10B).

The heavier precipitation shown in figure 10C occurred to the east of the mean trough extending from eastern Texas to Lake Superior.

REFERENCES

1. J. F. Andrews, "The Weather and Circulation of February 1962—A Month with Two Contrasting Regimes Associated with a Sharp Drop in Zonal Index," *Monthly Weather Review*, vol. 90, No. 5, May 1962, pp. 203–210.
2. A. I. Cooperman and H. E. Rosendal, "Great Atlantic Coast Storm, March 5–9, 1962," *Weekly Weather and Crop Bulletin, National Summary*, vol. XLIX, No. 13, March 26, 1962, pp. 7–8.
3. U.S. Weather Bureau, *Climatological Data—National Summary*, vol. 13, No. 3, March 1962, Chart IX.
4. H. C. Willett, "Statistical Behavior of the General Circulation of the Northern Hemisphere, October 1945–March 1952," *Scientific Report of the U.S. Weather Bureau-Massachusetts Institute of Technology Extended Forecast Project*, Cambridge, Mass., Sept. 1, 1960.
5. J. Namias, "The Index Cycle and Its Role in the General Circulation," *Journal of Meteorology*, vol. 7, No. 2, Apr. 1950, pp. 130–139.
6. D. E. Martin and W. G. Leight, "Objective Temperature Estimates from Mean Circulation Patterns," *Monthly Weather Review*, vol. 77, No. 10, Oct. 1949, pp. 275–283.
7. J. Namias, "Influence of Abnormal Heat Sources on Atmospheric Behavior," *Proceedings of the International Symposium on Numerical Weather Prediction, Tokyo, Nov. 7–13, 1960.*
8. U.S. Weather Bureau, *Daily Weather Map*, March 6–8, 1962.
9. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin, National Summary*, vol. XLIX, Nos. 10–14, March 5, 12, 19, 26, April 2, 1962.
10. A. I. Cooperman and H. E. Rosendal, "Great Atlantic Coast Storm, 1962," *Mariners Weather Log*, vol. 6, No. 3, May 1962, pp. 79–85.
11. U.S. Weather Bureau, *East Coast Storm March 5–9, 1962*, A Preliminary Report and Special Weather Advisories Issued, Washington, D.C., March 1962, 27 pp.

U.S. GOVERNMENT PRINTING OFFICE: 1962